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RESEARCH ARTICLE

PHYSICO-CHEMICAL AND NUTRITIONAL EVALUATION OF WHEAT GERM IDLI

Hemavathi, K., Abhilash, H. S., Amudha Senthil and *Sourav Kumar

Council of Scientific and Industrial Research-Central Food Technological Research Institute, Mysore-570020

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ABSTRACT

The objective of the present study was to utilize Wheat Germ (WG), a low cost industrial by-product (waste), but a nutritional capsule, filled with high quality protein (33%), oil 14-16% (ω-3/6.2, ω-6/55.7), antioxidants like tocopherols, glutathione, polyphenols, non-starch polysaccharides, healthy fiber and minerals by replacing expensive black gram to prepare popular traditional fermented steam cooked *Idli*. Trials were conducted by replacing 25, 50, 75 and 100% black gram with processed, Unflaked, Undamaged, Stabilized and Debitterized WG (USDWG), following traditional method of preparation. *Idli* prepared by replacing 50-100% Black Gram with WG, had improved nutritional values, textural and sensorial attributes. Natural fermentation rate was faster due to superior USDWG protein quality and quantity, enabling fermentation time reduction to almost half of control *Idli*, co-relating batter pH (4.4) and density (0.4g/cm^3). Significant difference was not observed in Viscoamylograph profile and invitro starch digestibility of the developed *Idli*. Prepared *Idli* had desirable sweet, sour, spongy texture, higher sensorial score and acceptability and can prove ideal vehicle to alleviate malnutrition constituting staple south Indian food due to its affordability. USDWG possesses strong anticancer and disease preventive properties as observed by the authors, translating developed *Idli* therapeutic, highly nutritive and traditional food at affordable cost.

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INTRODUCTION

Idli is a traditional cereal/ legume based naturally fermented steamed product with a soft and spongy texture which is highly popular and widely consumed as a food item in India (Renu Agarwal *et al.,* 2000). *Idli* makes an important contribution to the diet as a source of protein, calories and vitamins, especially B- complex vitamins, compared to the raw unfermented ingredients (Srilakshmi, 2003). *Idli,* also known as Rice cake, a favorite breakfast in south India with attractive appearance, appetizing taste, typical flavor, easy digestible, safe with good nutritional attributes, contributes its increasing popularity all over India (Manay *et al.,* 2001). Fermented foods are easy to digest and the nutrients easier to assimilate and also it retains enzymes, vitamins and other nutrients that are destroyed by food processing. Fermentation is well known for several thousand years as an effective and low cost means to preserve the quality for food safety Fermentation is an oldest known form of food biotechnology (Nazni *et al.,* 2010). The biochemical changes occurring during natural fermentation include increase in non-protein nitrogen, total acids, soluble solids, methionine, cystine and decrease in reducing sugars, pH and soluble nitrogen (Desikachar *et al.,* 1960; Steinkraus *et al.,* 1967). During natural fermentation water soluble B-vitamins and vitamin C increases and phytate phosphorous, which interferes with the absorption of both calcium and iron decreases significantly. There are reports that the rice and legume batter fermentation reduce phytate and tannin concentration (Hemalatha and Srinivasan, 2007). In recent time's fermented legume and cereal products are becoming popular in the developed countries due to their nutritive value and organoleptic characteristics (Sanjeev and Dhanwant, 1990). Fortification of popularly consumed staple foods, such as cereals, with inexpensive plant protein sources, notably legumes, has been increasingly exploited in these countries. By this way, the protein quality of staple foods is improved through a mutual complementation of their limiting amino acids (Annan *et al.,* 2005). In most of the countries, rice is fermented either by using mixed culture(s)into alcoholic beverages, or by natural fermentation in to leavened batter formed dough breads which are usually baked or steamed (Yokotsuka, 1991). Research has revealed that by the process of fermentation flavor enhancing compounds, useful enzymes and essential amino acids are produced. Some fermentation microorganisms have been found to produce antimicrobial products that lead to safe and long storing of foods. Probiotics are live microbes associated with fermentation that, upon ingestion, beneficially affect their host by improving the balance of the intestinal microflora (Kalui *et al.,* 2010). Understanding the importance and popularity of *Idli* in Indian diet, we attempted to convert it into more nutritive, therapeutic, more tastier and affordable by replacing expensive black gram (BG), by WG a low cost (1/10th cost of BG) industrial

Corresponding author: **Sourav Kumar,**
Council of Scientific and Industrial Research-Central Food Technological Research Institute, Mysore-570020.

waste/by-product, which is usually sold as a cattle feed. Attracted by the hidden nutritional virtues of WG, our team successfully attempted isolating/ extracting, undamaged/ unflaked, intact, wholesome WG, in a Commercial Roller Flour Mill. The amazing nutritional, therapeutic and health beneficial properties of WG get reduced to almost half, if it is damaged or flaked during separation process. Though considered as health capsule, it is deprived of becoming part of regular human diet because it is highly unstable, turns rancid rapidly and has slightly vegetative, astringent bitter after- taste. Therefore, our team after industrially isolating WG in its intact form without damaging it then stabilized and debitterized it (patent have been submitted at institute level). We have successfully substituted/incorporated Undamaged Stabilized Debitterized Wheat Germ (USDWG) and attempted to make it a part of regular diet through traditional fermented food products like *Idli*/, because, USDWG is excellent source of high quality protein 33%,(PER-3, PDCAAS-0.9), polyunsaturated fatty acids (ω-3, ω-6), vitamin-E (richest vegetative source), Vit-B,Poly phenols, healthy fiber and vital minerals also USDWG possess potent anticancer properties. Nutritional profile of BG as reported, protein 27%, PER-1.5, PDCAAS-0.7 (Alsmeyer *et al.,* 1974). Proximate composition of ingredients which is used for preparation of *Idli* is furnished in the table 1. In a pilot clinical study it has been observed that Fermented WG Extract (FWGE), when administered together with anti-inflammatory drugs in patients with severe rheumatoid arthritis (RA), could significantly improve disease outcome (Balint *et al.,* 2006). Fermented USDWG extract prevents chemotherapy induced febrile neutropenia (Garami2004). Avemar (MSC) is a nontoxic fermented WG extract demonstrated to have antitumor effects. Avemar has the potential to significantly improve the survival rate in patients suffering from malignant colon tumors (ChristophIllmer *et al.,* 2005). The anticancer compound 2, 6-dimethoxy-1, 4-benzoquinone (DMBQ) is the major bioactive compound in FWGE and is probably responsible for its anticancer activity (Christoph Otto *et al.,* 2016). The present research was undertaken to utilize WG by converting it a part of regular human diet through systematic scientific and technological intervention. Various physio-chemical tests of the WG batter and organoleptic evaluation of the developed *Idli* were carried in the study. Three types of *Idli* were prepared namely Control *Idli,* Mixed *Idli* and USDWG *Idli* using different ratios of BG, and USDWG furnished in the table number 2. The developed USDWG *Idli* was superior in nutritive and textural attributes having high sensorial scores and acceptability.

MATERIALS AND METHODS

Raw Materials

The raw materials selected for this study were (a) polished rice (*Oryza sativa),* (b) decorticated Black Gram (BG) (*Vignamungo*) were procured from local market, and (c) Wheat Germ (WG) was procured from 150 Tons / day milling capacity M/s Basaveshwara Roller Flour Mill, Metagalli, Mysore, Karnataka employing the patented CFTRI technology by the authors.

Preparation of *Idli*

The polished rice, decorticated black gram (BG) and USDWG were soaked separately (water used for soaking Rice-150%, BG-150% and USDWG-200%) for 4 hours. After separating excess of water, rice, BG and USDWG were separately ground in wet grinder (Ultra table top grinder of 2 liter capacity) by adding required quantity of residual water (Grinding time for Rice-8 mins, BG – 6mins and USDWG- 6mins) containing soluble proteins then individual batters were mixed in the ratios as shown in the Table No. 2. Control and composite batters were allowed to ferment for 14 hours (overnight) in incubator maintained at 30^0C. Fermented batters were then poured into the *Idli* cups of *Idli* stand and steamed in *Idli* steamer for 20mins to get the final product. This is the well-known traditional method of *Idli* preparation which was followed for the preparation of *Idli.*

Table 1. Proximate composition of Rice, Black Gram and Undamaged, Stabilized, Debitterized Wheat Germ (USDWG)

Parameters (%)	Rice*	Black gram*	USDWG
Moisture	13.3	10.9	13.0
Protein	6.4	24.0	32.0
Fat	0.4	1.4	16.0
Fiber	0.2	0.9	3.5
Minerals	0.7	3.2	5.0
Carbohydrates	79.0	59.6	35.0-45.0

*Source: Gopalan *et al.* (1971)

Table 2. Proportion of ingredients for *Idli* preparation

Samples	USDWG	Rice (Grams)	Dhal (Grams)
Control *Idli*	0	100	50
Wheat Germ *Idli*	50	100	0
Mixed *Idli*	25	100	25

USDWG - Undamaged, Stabilized, Debitterized Wheat Germ

pH and Density of the batter(g/cm^3)

Initial and final pH of the samples was measured using a pH meter (Cyberscan – Eutech Instruments, India). The batter density was determined by the volume of known weight batter before and after natural fermentation.

Measurement of CO_2

Amount of CO_2 released by the fermented batter was assessed using CO_2 Analyzer (phi dan sensor, Denmark) (Rekha *et al.,* 2011).

Viscosity of batter

The viscosity of batter before and after fermentation was measured using Brookfield viscometer (Model DV-III, Stoughton, MA, USA) according to (Kim and Walker1992), with slight modifications. *Idli* batter was transferred to 100ml beaker and leveled up to the brim. The experiment was carried out at room temperature. The ASTM spindle speed was set to 100rpm.

Micro Viscoamylograph studies

The pasting properties of the flour/hydrocolloid blends were determined using the Brabender MVAG (Braebender, Duisburg, Germany). 10 grams of flour was weighed on a 14% moisture basis and shaken with 100 g water. The slurry was stirred in the MVAG at 250 rpm. The slurry was heated from 50 to 95°C at 6°C/min and then held at 95°C for 5 min. The slurry was then cooled back to 50°C at 6°C/min and held for 2 min. Peak viscosity, hot paste viscosity (HPV), end of cooling, final viscosity, breakdown, and setback values were all determined and reported in Brabender units (BU). The peak viscosity was the first maximum viscosity of the slurry. The HPV was the minimum viscosity during the hold period. The end of cooling was the viscosity of the slurry at the end of the cooling period. The final viscosity was the viscosity of the slurry at the end of the test. The breakdown is defined as the difference between peak viscosity and HPV. The setback is defined as the difference between the peak viscosity and the viscosity at the end of cooling (Ademolamonsur Hammed. 2016)

Invitro starch digestibility

In vitro starch digestibility was analyzed according to the method of (Goni *et al.,* 1997) with some modification. About 50mg of defatted sample was incubated with amyloglucosidase in acetate buffer (pH 4.6) at 60^0C for 30min. This was centrifuged at 1500rpm for 15-20 min after inactivation of enzyme by boiling. The supernatant obtained was made up to 15 ml and 20μl was taken for analysis of glucose release using (glucose oxidase peroxidase) GOD-POD kit (span Diagnostics Ltd., Ahmedabad, India). GOD oxidizes glucose to gluconic acid and hydrogen peroxide. Hydrogen peroxide in the presence of peroxidase enzyme couples with phenol and 4-aminoantipyrine to form quinoneimine dye. The intensity of developed colour was measured at 505nm in spectrophotometer. Which is corresponding to hydrolysed starch and glucose released. Percentage of glucose release was converted to starch by multiplying glucose percentage with 0.9.

Nutritional attributes of developed *Idli*

Proximate analysis

Proximate composition of the developed products viz, moisture, fat was analyzed according to the standard methods (AOAC 2005) and ash, protein (AACC 2000).

Color of the *Idli*

Color of the product was evaluated using Hunter lab color flex model DP – 9000 D25A in terms of Hunter L (lightness, ranging 0-100 indicating black to white), a (+a, redness and –a, greenness) and b (+b, yellowness and –b, blueness). View angle 10° (Nisha *et al.,* 2005).

Texture analysis of the *Idli*

The texture of '*Idli*' was *analyzed* using texture analyzer with a cross head speed of 5 mm/s and with 50% compression for hardness, adhesiveness and stickiness parameters (Bharti and Laxmi, 2008). Measurements were performed in three replicates and the average values were reported in Newton (force).

Mineral estimation

Mineral content of the samples was analyzed by using atomic absorption spectra according to the method described by (De-LaFuennea *et al.,* 2003) with slight modification. Sample (5gm) was incinerated in a muffle furnace 570˚C for 24 h. The ash obtained was dissolved in concentrated HNO_3 (2ml) and warmed for 5 min at 40˚C in a water bath. The mixture was then filtered and analyzed by atomic absorption spectra (iCE 3000AA, Thermo Scientific, U.S.A).

Sensory evaluation of the *Idli*

Idli prepared with different batters were subjected to sensory evaluation by Quantitative Descriptive Analysis (QDA) (Stone and Sidel, 1998). Employing trained expert panel members. During initial session, descriptors of the product were obtained by "Free choice profiling". Panelists were asked to describe the samples with as many spontaneous descriptive terms as they found applicable. The common descriptors chosen by more than one third of the panel was used in preparing a score card consisting of a 15 cm scale wherein 1.25 cm was anchored as low and 13.75 cm as high. The panelists were asked to quantify the perceived intensity of attributes by making a vertical line on the respective scale and writing the code number of the sample. They were also asked to indicate the overall quality of the product on an intensity scale which was anchored at very poor, fair and very good to assess the liking or preference of the product. The scores for all the attributes were tabulated and the mean values were calculated. These mean scores represented the panel' judgments about the sensory quality of the samples.

Statistical analysis

The experiments were conducted for three replications of each analysis. The collected data were compiled and analyzed by statistical methods using ANOVA test to evaluate the significant differences as described by (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

Changes in the pH during natural fermentation (14 hours)

pH changes of naturally fermented batter is represented in the Fig. 1. The pH of the control batter at 0 hour was 6.2 which decreased to 4.1 after 14 hours of natural fermentation whereas WG incorporated batter dropped down from 6.2 to 3.8, pH of mixed *Idli* batter decreased from 6.0 to 3.8 respectively. It is evident from Fig. 1.WG incorporated batter had lower pH and higher acidity compared to control batter probably because, WG is a very good substrate for the microbes due to the presence of high amount of simple protein (PER 3) and fermentation supporting nutrients, resulting in accelerated rate of fermentation compared to control batter, contributing to desired sour taste in the final product. Therefore, it can be concluded that fermentation time of WG batter can be conveniently and advantageously reduced than control *Idli*. This phenomenon is significantly beneficial for large scale production. This is mainly associated with the development of *S. faecalis* producing lactic acid which lowers the pH and production of carbon dioxide, which leavens the batter (Mukherjee *et al.,* 1965)

Changes in the Density of the batter during natural fermentation (14 hours)

Densities of three batters under investigation noticeably decreased during natural fermentation were conspicuous and conclusive. The control batter density decreased from 1.03 to 0.72 gm/cm^3, mixed batter had 0.56 gm/cm^{3}whereasWG batter decreased from 1.02 to 0.4 g/cm^3 during natural fermentation. It is a known fact, density of the batter decreases in progression with increasing fermentation time due to

Table 3. Physical properties of *Idli*

	Texture			Color			
Samples	Hardness (N.s)	Stickiness (N.s)	Adhesiveness (N.s)	L	a*	b*	ΔE
Control *Idli*	29±1[c]	0.10±0.01[a]	0.05±0.005[c]	84.09±0.1[b]	1.04±0.04[c]	10.35±0.1[a]	12.77
Wheat Germ *Idli*	20.±1.1[a]	0.13±0.01b	0.02±0.01[a]	81.5±0.3[a]	0.6±0.2[b]	12.26±0.06[c]	21.60
Mixed *Idli*	23±1.5[b]	0.16±0.01c	0.05±0.01[b]	82.7±0.4[a]	0.2±0.001[a]	11.1±0.09[b]	18.81

Each value is mean of three replicates and followed by ±SD; L- Lightness (black/white), a*- (green/red) and b*- (blue/yellow); -Means in the same column followed by different letters differ significantly at (p≤0.05). N.s-Newtons.

Table 4. Proximate analysis of *Idli*

Samples	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	IVSD(%)
Control *Idli*	57.9±0.51[a]	0.45±0.05[a]	0.13±0.01[a]	14.5±0.3[b]	15.2±0.2[a]
Wheat Germ *Idli*	62.9±0.09[c]	0.7±0.02[c]	3±0.17[c]	16.36±0.15[c]	37.5±0.1[c]
Mixed *Idli*	58.2±0.54[b]	0.6±0.01[b]	0.40±0.02[b]	15±0.1[a]	36.3±0.02[b]

IVSD- Invitro starch digestability; Each value is mean of three replicates and followed by ±SD; -Means in the same column followed by different letters differ significantly at (p≤0.05). N.s-Newtons

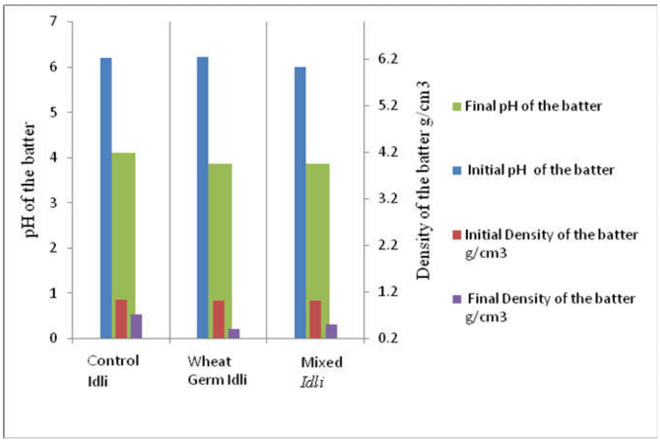

Figure 1. Changes in the pH and density of the batter during natural fermentation (14 hours)

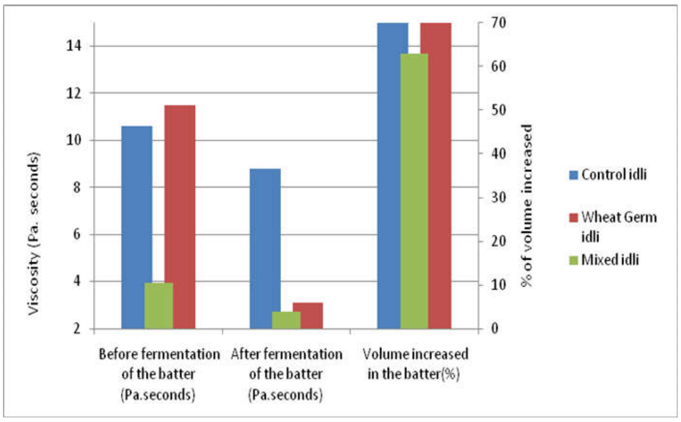

Figure 2. Changes in the viscosity of the batter and percentage of volume increased in the batter during natural fermentation (14 hours)

exponential multiplication of yeast / bacterial cells and higher gas production, consequently batter volume increases in proportion concurrently. The volume increase of the batter is due to combined effect of gas production and gas holding (retention) capacity of the batter, therefore, increased WG batter volume conclusively proves, higher gas holding capacity besides higher gas producing capacity of the WG batter. This was because of the entrapment of the air/in gas pockets and the function of the microbes responsible for the different functionality of batter density (Mukherjee *et al.,* 1965). As shown in the Fig. 1. Study reveals, in WG *Idli* and mixed *Idli*, gas holding capacity was higher compared to control *Idli* hence density of the batter accordingly decreased.

Increase in batter volume during natural fermentation

There was a noticeable change in batter volume during natural fermentation at the end of the 14 hour. It was observed there was 80% rise in WG *Idli* batter, followed by 63% rise in the mixed *Idli* but in the case of control *Idli* batter had only 31% increase in batter volume (Fig.2). Therefore it can be conclusively stated, WG *Idli* batter had higher fermentation resulting in higher lactic acid production, higher CO_2 production, higher gas holding capacity compared to control batter proving its overall superiority over control batter. The increase in volume might be due to the CO_2 production by the yeast during natural fermentation (Rekha *et al.,* 2011). This is also because of the combined contribution of both hetero fermentative lactobacilli and non-LAB (Thygaraja *et al.,* 1992).

Viscosity of the batter

Significant difference in the flow behavior of WG batter, before and after fermentation was observed but, not much difference was noticed in the batter consistency of control *Idli* as shown in the figure 2. Control *Idli* batter, WG and Mixed *Idli* batter had comparative initial viscosity10.6Pa.s 11,5Pa.s and 10.45Pa.s respectively, whereas post fermentation (14 hours) there was marked reduction in viscosity of WG and mixed *Idli* batter 3.1Pa.s and 3.68Pa.s respectively as compared to control (8.8 Pa.s). Lower viscosity of WG *Idli* batter (3.01Pa.s) conclusively proves its accelerated fermentation that liquefied the batter, formed strong non-Newtonian behavior (Pseudo plastic or shear thinning) (Debasree Ghosh *et al.,* 2011). Reduced viscosity of WG batter confirms increased fermentation rate which is in agreement to our earlier conclusion.

Micro-viscoamylograph

Viscogram and data obtained by micro-viscoamylograph suggests WG *Idli* had delayed lower Gelatinization Temperature (GT) 10 BU compared to control *Idli* 19 BU indicating presence of resistant starch. Lower Paste Viscosity (PV) and cold Paste Viscosity of WG *Idli* 125 BU and 212 compared to control *Idli* having 226 and 299 BU respectively indicating WG *Idli* would be softer due to lesser retro gradation of starch. Break down 3, and 1 whereas set back values of WG *Idli* and control *Idli* were 83 and 64 respectively indicating comparable softness characteristics of the starch.

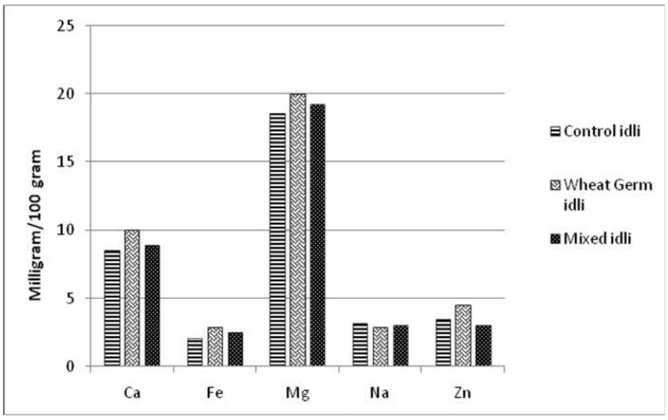

Figure 3. Estimation of Minerals

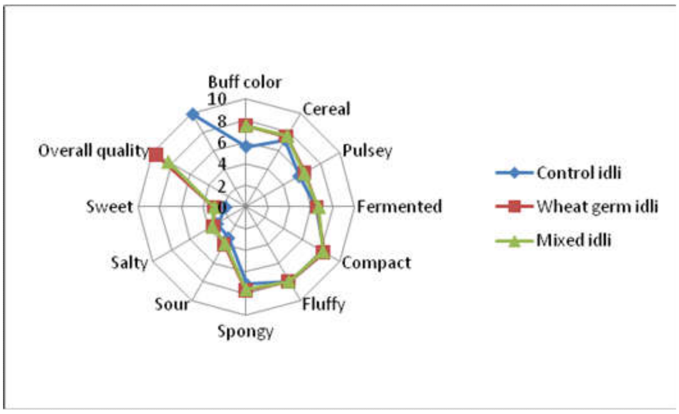

Figure 4. Quantitative Descriptive analysis of prepared *Idli* given by sensory department

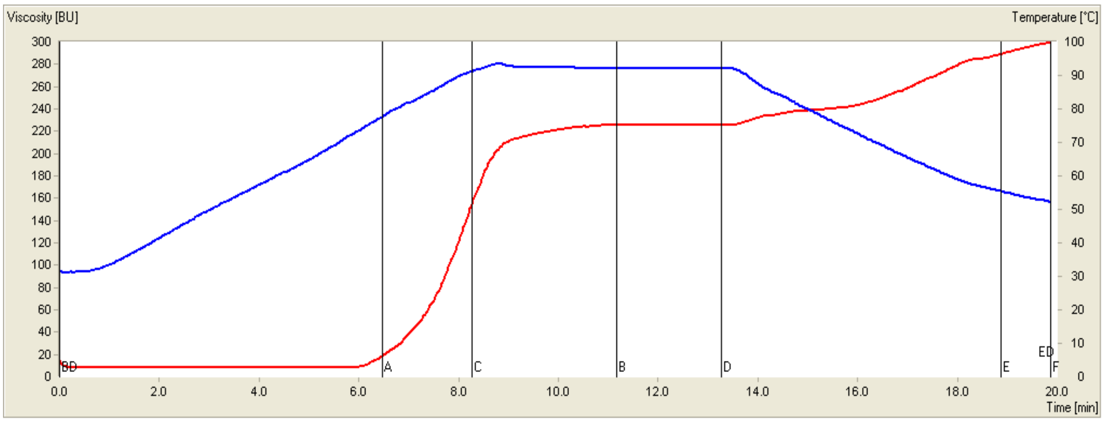

Fig 5(a). Viscoamylograph of Control Idli

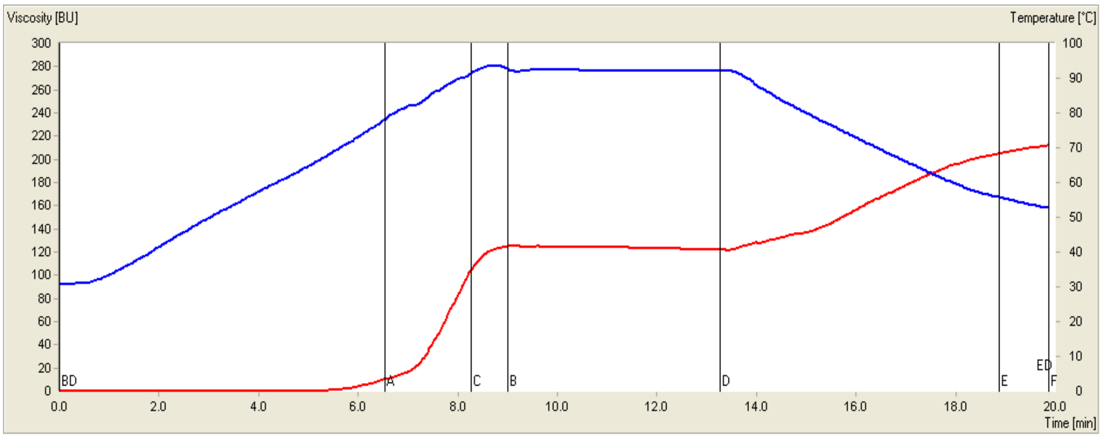

Fig 5(b). Viscoamylograph of Wheat Germ idli

Fig 5. Viscoamylograph of developed products

Hence, *Idlis* which are consumed steaming hot will not have overall difference in eating quality of both WG and control *Idli* (Fig no. 5(a) and 5(b)).

Texture of the *Idli*

Table 3 shows the result of textural studies of prepared *Idli*'. Hardness is measured as the peak force during compression in the first cycle. Hardness of control '*Idli*' was 29 Newton, WG *Idli* was 20 Newton, and mixed *Idli* shows 23 Newton respectively. These values indicated that control *Idli* of fered higher resistance to compression than WG *Idli* and mixed *Idli,* indicating developed product was easy to bite therefore it was softer compared to control.

This can be attributed to higher CO_2 production, higher CO_2gas holding capacity and higher fluffiness of the *Idli* batter, which may be due to higher number of microbes present in WG incorporated *Idli* especially yeast, resulting in a softer product. Insignificant difference in stickiness values of all the three *Idli*s prepared was observed, as control had0.10 Newton, WG *Idli*0.13 and mixed *Idli* 0.16 Newtons respectively. Similarly, in the adhesiveness values of all the three *Idli*s also did not vary significantly, as control showed 0.05 Newton, WG and mixed *Idli* had 0.02, and 0.04 Newton adhesive forces respectively, hence, there is no marked difference in the developed *Idli* compared to control *Idli*, with respect to adhesiveness and stickiness.

Color of the product

L values of WG incorporated *Idli* was81.5, mixed *Idli* 82.7 where control shows 84.09 indicating WG *Idli* has less degree of whiteness compared to control *Idli*, b values of WG *Idli* was 12.26, mixed *Idli* 11.1and control *Idli* recorded 10.35 respectively indicating WG incorporated *Idli* are more yellowish than control (Table 3) as expected due to presence of carotenoids (precursor of Vit A) and other nutritive components like tocopherol and WG oil having ω -3, ω -6 fatty acids. The acceptable range of Hunter L value of the *Idli* is75 and above, that of the b values is below 13 (Nisha *et al.,* 2005).

In-vitro starch digestibility

Data obtained by estimating in-vitro starch digestibility of control and WG *Idli* were 15.2 % and 37.5% which clearly indicates better and easy digestibility of WG *Idli* Therefore WG *Idli* would be desirable for patients and people who need faster and higher calories table no.4.

Minerals estimation

Mg and Cu content of WG *dosa* did not vary compared to control (0.018mg and 0.004mg respectively). While the respective levels of Fe, K, Zn and Mg increased from 0.059mg to 0.0614mg, 0.048mg to 0.057mg, 0.021mg to 0.039mg and 0.0035mg to 0.015mg for WG *Idli* when compared to Control *Idli* (mg/100g). As shown in the Fig. 3

Sensory evaluation of WG *Idli*

The sensory scores of differently prepared *Idli* are furnished in the Fig 3. Yeast involved in the fermentation not only contributes towards gas production, which results in good texture, but also towards the sensory attributes of the *Idli* (Soni and Arora2000).Sensorial attributes of WG *Idli* are similar to control viz sponginess, compactness and fluffiness. Sensory evaluators felt Mixed *Idli* had only sour and sweet taste but lacked in sponginess and fluffiness than control *Idli*, whereas WG *Idli* shows more sour, sweet, along with sponginess and fluffiness texture when compared to control due to the higher CO_2 incorporation entrapment in the batter during fermentation which was comparatively less in control. Overall quality score of WG *Idli* was 9.9, mixed *Idli* 8.5 and control10respectively.

Nutritive value of the developed *Idli*

The data pertaining to nutritive value of the developed WG based *Idli* is represented in Table 4. The protein content of WG *Idli* was highest with 16.3%, control *Idli* 14.5% and mixed *Idli*15% respectively indicating WG *Idli* had the highest and control *Idli* had the lowest protein content. WG contains 14-16% fat, accordingly fat content of *Idli* increased with the increased WG proportion in the *Idli* batter agreeing with fat content values of WG *Idli* 2.9%, mixed *Idli* 0.4% and control 0.13% respectively. WG owing to high fiber and mineral content exhibits high ash content (4-5%), accordingly increased proportion of WG in the batter, ash content of respective *Idli* has also shown increasing trend explain scientific logic as reflected in the ash values of control *Idli* 0.45%, mixed *Idli* 0.6% and WG *Idli* 0.7% respectively. Even moisture content of the WG incorporated *Idli* shows higher value 62.9%, mixed *Idli* shows 58.2% compared to control 57.9% due to higher water absorbing and binding capacity of WG.

Conclusion

Successful attempt was made to develop traditional fermented food, *Idli* by completely replacing BG with WG, a low cost industrial by-product. WG is packed with nutrients viz. high amount of simple functional protein, minerals; supports yeast fermentation, exhibiting accelerated fermentation rate and rapid gas production, which gets entrapped within batter in the form of stable bubbles. WG *Idli* was superior to control with regard to protein and fat content, texture and sensorial attributes besides being more cost effective. Accelerated rate of fermentation facilitated reduction in fermentation time, which is advantageous for large scale *Idli* production and also convenient for domestic preparation. Higher values of in-vitro starch digestibility and viscoamylograph results conclusively suggest quicker assimilable quality of WG *Idli* hence it is more easily digestable than control *Idli* which goes in favor of newly developed *Idli*. The developed process being identical to the traditional method of preparation therefore its acceptability and adaptability will be simple and easy if marketed as ready mixes or instant mixes. This opens up avenues for vast industrial exploitation and employment generation. Present invention has successfully converted industrial waste to nutritionally dense traditional popular food that can easily reach most vulnerable target population at a very affordable cost proving best vehicle to eliminate, control and eradicate malnutrition of our country.

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